Strategic rigidity and foresight for technology adoption among electric utilities

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HIGHLIGHTS

- Present a firm-level perspective on technology adoption behavior among electric utilities.
- Firms with mature technology can become rigid towards newer technologies.
- Case study analysis of a major electric utility firm.
- Implications of 'technology rigidness' on the energy eco-system.

Keywords:
Strategic foresight
Technology adoption
Peripheral vision

ABSTRACT

The variation in the adoption of a technology as a major source of competitive advantage has been attributed to the wide-ranging strategic foresight and the integrative capability of a firm. These possible areas of competitive advantage can exist in the periphery of the firm's strategic vision and can get easily blurred as a result of rigidness and can permeate in the decision-making process of the firm. This article explores how electric utility firms with a renewable energy portfolio can become strategically rigid in terms of adoption of newer technologies. The reluctance or delay in the adoption of new technology can be characterized as strategic rigidness, brought upon as a result of a firm's core competence or core capability in the other, more conventional technology arrangement. This paper explores the implications of such rigidness on the performance of a firm and consequently on the energy eco-system. The paper substantiates the results by emphasizing the case of Iberdrola S.A., an incumbent firm as a wind energy developer and its adoption decision behavior. We illustrate that the very routines that create competitive advantage for firms in the electric utility industry are vulnerable as they might also develop as sources of competitive disadvantage, when firms confront environmental change and uncertainty.

1. Introduction

The fundamental question concerning firms is the manner in which they can sustain competitive advantage. In answering, scholars have considered the resource-based view (RBV) to be the underlying reason for firm performance heterogeneity. The resource-based view proposes that firms within an industry differ in the resources and capabilities they own and control leading to heterogeneous positions within the industry. Accordingly, each firm within a specific industry can be considered as a bundle of resources and capabilities (Barney, 2001). Prior research suggests that organizational capabilities are essential for competitive advantage and a major source of firm performance (Wernefelt, 1984; Richard and Weick, 1984; Miles and Snow, 1978; Barney, 2001). The distinction in the adoption of technology can be recognized to the core competence or integrative capability of a firm (Selznick, 1957). Importantly, competitive advantage gained through the adoption of an innovative technology can be temporary at best. So it is essential for firms to identify new opportunities resulting from new technologies for sustainable competitive advantage. Research perspectives on organizational traits and capabilities are associated with technological opportunism (Richard and Weick, 1984; Miles and Snow, 1978; March, 1991). Further, Miles and Snow's (1978) typology suggests that a technologically opportunistic firm senses technology prospects and responds to capitalize (or counter) on these opportunities (or threats). Similarly, technologically opportunistic firms are in an enactment mode (Richard and Weick, 1984) with respect to new technologies, exploring several new technologies that could threaten their organizations or be sources of opportunity (Day, 1994; Teece et al., 1997).

The literature on adoption of new technologies has been well established in the field of organization and management studies.

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Table 1
Seminal contributions from different domains on organizational adoption of an innovative technology (Srinivasan et al., 2002).

Reference	Field	Context	Main findings and conclusions
Dewar and Dutton (1986)	Organizational theory	Relate adoption processes of incremental and radical innovations in the footwear manufacturing industry	Extensive knowledge depth influences the adoption of radical innovation
Christensen (1997)	Technology strategy Organizational theory	Response to disruptive technologies in the disk drive industry	Firms that have a competence in a given industry's dominant design and vested interests in mainstream customers unable to take advantage of the potential of disruptive technologies
Ettlie et al. (1984)	Organizational theory	Adoption of radical versus incremental production systems adoptions by firms in the food processing industry	Organizational learning associated with incremental adoption rather than radical innovation or adoption
Christensen and Bower (1996)	Technology strategy	Customer power and the failure of leading firms world disk drive industry	Established firms led the industry in the development of all types of technologies when the technologies addressed existing customers' needs
Leonard-Barton (1992)	Technology strategy	New product and process development projects in five firms/ industries: Ford Motor, HP, Chemicals, Steel and Electronics (see citation for further literature)	The core capabilities of a firm have a down side "core rigidities" that inhibit innovation in organizations
Kimberly and Evanisko (1981)	Organizational Theory	Adoption of medical technology innovations and electronic data processing by hospitals	Individual, organizational and contextual variables were found to be predictors of technological innovations
Karshenas and Stoneman (1993)	Economics	Adoption of CNC machines in the UK engineering industry	Supports rank and endogenous learning effects. Factors affecting the diffusion include firm size, industry growth rates and cost of technology
Zmud and Apple (1992)	Information systems	Scanners by supermarkets	Early adoption explained by chain size
Woiceshyn and Daellenbach (2005)	Industrial Organization, Strategic management	Oil firms	Adoption process explained by integrative capability developed through a dynamic interplay of adoption process and knowledge systems

Table 1 illustrates some seminal contributions on organizational adoption of innovative technologies in different industries. In our paper we focus on the electric utility industry. Often, the literature on energy policy has been based on the assumption that the focus of a study should be on the energy system as a whole and policy initiatives with respect to deregulation, investment and environmental impact have to be considered as a part of this system where energy is generated, transmitted distributed and finally to consumed. Yet, while paying a lot of attention on the effects of the institutional environment, the literature has largely neglected the firm level effects on the adoption of new technology in the electric utility industry. This paper tries to fill this gap by exploring the firm level effects as well as the role the firm within the energy ecosystem. It investigates the role of a firm's capability in an established technology and its function in influencing firm's new technology adoption decisions. Particularly, we study the role of strategic rigidness – brought upon as a result of a firm's competitive advantage in a different technological arrangement and its implication for the adoption of new renewable energy (RE) technologies. Fig. 2 establishes the foresight of an electric utility firm involving various stakeholders within an ecosystem.

Most of the energy firms have a renewable portfolio aimed at increasing utilities' adoption of RE technology to improve the sustainable production of energy. While some utility firms have made strong undertakings in distributing electricity from RE sources, others have postponed this practice. We argue that stronger capabilities in conventional technology can turn into rigidities pushing these firms to further exploit the more mature technology rather than investing in the new innovative technologies (Nisar et al., 2013). To our knowledge, this is the first study to provide a firm based explanation on the organizational adoption of a technology and understand why some electric utility firms adopt a certain RE technology while others do not. We further build on

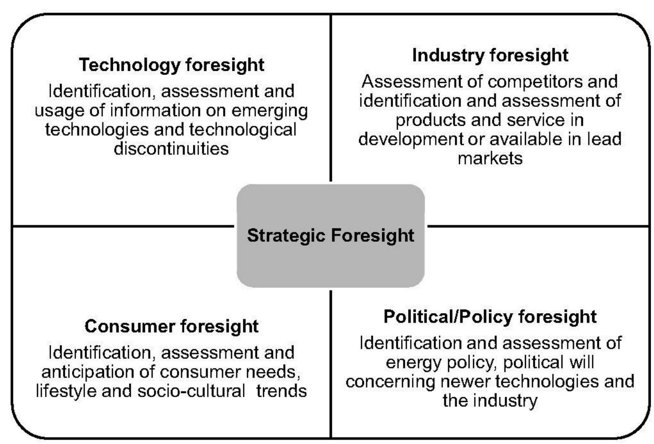

Fig. 1. Components of strategic foresight for technology adoption, specifically in the electric utility industry.

our initial work to include the concepts of foresight in an ecosystem for technology adoption among electric utilities (see Nisar et al., 2013).

The paper is structured as follows: the first section presents an overview of the conceptual framework by highlighting the relevant literature on strategic rigidity and firm performance. The following section presents different barriers to adoption of RE technology by emphasizing the various policy implications. In the last section, the case of Iberdrola S.A. is presented to illustrate some empirical evidence on the suggested interactions in the conceptual framework. The paper concludes with some recommendations and possible future research lines.

2. Strategic foresight and organizational learning

In this section, we borrow concepts from futures studies to provide a more rounded understanding on technology adoption and strategic rigidity based on organizational learning. Bootz (2010) suggests that an agreement seems to emerge between practitioners and theorists about the strong ties linking strategic foresight and organizational learning. In this paper, we consider strategic foresight as means to counter strategic rigidity. More specifically, we focus on strategic foresight and peripheral visions as tools for firms to understand the future. The research stream on peripheral vision has from the outset been primarily concerned about the firm perspective. The fundamental proposition is that firms need to look for information that lies outside their core capabilities and core competence. Scanning for technological and market developments is essential for survival and these areas of competitive advantage can possibly lie in the periphery of the firm. Fig. 1 formulates the components of strategic foresight for a firm's long-term survival within an industry.

3. The conceptual framework

This paper explains how organizational capabilities along with other factors like environmental uncertainty might create strategic rigidity within a firm (Fig. 2). In case of a utility firm, a firm's capabilities in a traditional technology can result in the late adoption of a RE technology that is innovative, which can hold the possible competitive advantage in the future. These possible areas of competitive advantage can possibly exist in the periphery of the firm's strategic vision and can get easily blurred as a result of rigidness and can permeate in the decision-making process of the firm (Day and Schoemaker, 2005)

Fig. 2 depicts how an electric utility firm's decision to adopt a certain technology can be affected by the core capabilities in a mature technology, relate to firm performance and also influence the energy eco-system. In case of an electric utility, the decision on whether to invest in a new coal-fired power plant or an offshore wind park determines output for decades to come (Wustenhagen and Menichetti, 2012). These decisions are critical in determining a firm's long-term competitive advantage. To refine the understanding of the mechanisms underlying strategic rigidity, the paper builds on the insights from organizational theory and strategic management literature, particularly, the idea that routines are costly and difficult to change once they are institutionalized. The paper explains this notion by outlining the case of Iberdrola S.A. – the world's largest RE developer and Spain's largest utility firm (RechargeNews, 2012). This case study highlights the core competence of Iberdrola in the wind energy and as one that imparts competitive advantage in the RE market. Iberdrola's expertise, know-how and superior capability in a more mature technology arrangement (wind energy) has made it strategically rigid in terms of adopting an innovative technology (concentrated solar power).

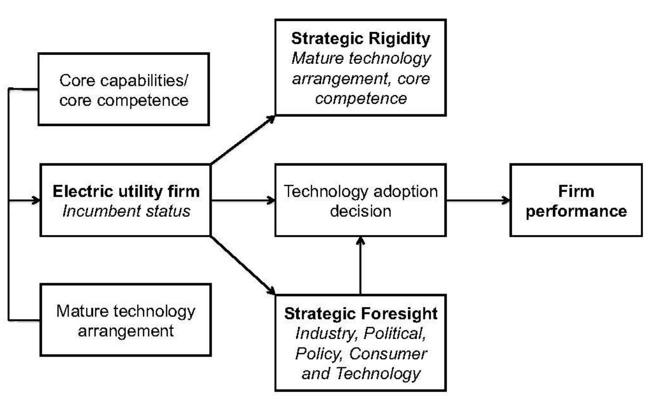

Fig. 2. Conceptual framework involving strategic foresight and strategic rigidity for technology adoption decision.

4. Strategic rigidity and firm performance

In the face of increased competition, unstable regulatory frameworks and rapid technological changes sustainable competitive advantage is of profound importance to utility firms and these factors can undermine its longevity. For example, dynamic and aggressive rivals can erode the market share of industry leaders, eventually leading to their dethronement (Ferrier et al., 1999). Wiggins and Ruefli (2005) understand that prior research identifying firms with sustained competitive advantage can be achieved as a series of temporary advantages over time. In case of a utility firm, achieving competitive advantage requires managers to understand the bases of competitive advantage as well as the factors that lead to dynamic changes in these bases that allow them to concatenate a series of temporary advantages (Sirmon et al., 2010). This series of competitive advantage or disadvantage is reliant on the strategic choices and decisions that a firm makes, for example, the decision of a merger or an acquisition of another utility firm or the adoption of a innovative technology. For instance, Iberdrola S.A. acquisition of Scottish Power Plc. in 2007 can be categorized as a strategic choice to gain sustained competitive advantage in wind energy (see Section 5).

In theory, strategic choices are characterized by unique, novel, ambiguous and complex decision contexts; they require resource commitment (or the decision not to commit), and they are not easily reversible (Bansal, 2005; Eisenhardt and Zbaracki, 1992). However, the very routines that create competitive advantage in firms are vulnerable as they develop as 'core rigidities,' or sources of competitive disadvantage, when firms confront environmental change. Given that the RE domain is ever evolving firms need to become agile to sustain their competitive advantage. Yet, firms with a certain level of expertise in mature technologies can become strategically rigid, thus undermining the adoption of new technologies.

The concept of capabilities as a core competence is not new. The idea of capabilities has been discussed at length within strategy literature and its significance has been discussed for decades stimulated by such research as Rumelt's (1974). Rumelt (1974) found that of nine diversification strategies, the two that were formulated on an existing skill or capability in the firm were associated with the highest performance. Moreover, research has shown that industry-specific capability increases the likelihood for a firm to exploit new technology within the industry (Mitchell, 1989). Prior literature supports the idea that effective competition is based on incremental innovation that exploits developed capabilities (Hayes, 1985; Quinn, 1980).

Entry into new niche technologies corresponds with the expansion of a firm's technological capabilities to drive innovation within and across technological domains. Prior research suggests that firms tend to maintain their competitive advantage by branching into new domains by recombining new with old knowledge and capabilities and branching into new technology domain increases the stock of opportunities to which the firm has access (Fleming, 2001; Fleming and Sorenson, 2004).

The knowledge components that the firm acquires in the new domain can then be recombined with its existing knowledge to introduce heterogeneity that facilitates problem solving (Amabile, 1988; George et al., 2008). Since older firms are more likely to have accumulated experience and slack resources (Penrose, 1959), it is expected that they stand to benefit more from branching into new niches than younger firms, if they can combine the process of branching with their core capabilities.

However, Lieberman and Montgomery (1988) argue that institutionalized capabilities can lead to 'incumbent inertia' in times of environmental changes. Therefore, capabilities in an existing technology might destroy firm performance particularly when technology discontinuities cause the existing competencies to become obsolete (Tushman and Anderson, 1986). We will provide some empirical evidence from the case of Iberdrola to show how capabilities in a mature industry might lead to strategic rigidity in adoption of new technology.

5. Case study: Iberdrola S.A.

Iberdrola is the world's largest RE developer and Spain's largest utility firm. The case of Iberdrola is considered for two reasons. First, it is the world's largest wind energy developer and as result of its incumbent status within the industry it provides a good example for studying core capabilities and firm performance. Second, it is insightful to draw certain propositions based on the mergers and acquisitions of Iberdrola in terms of technology adoption behavior. Lastly, we study the technology adoption decision of Iberdrola for a newer technology of concentrated solar power. According to International Energy Agency, one of the key rationales of CSP at a firm level is the possibility of integrated thermal storage and an important feature of CSP plants is that virtually all of them have fuel-power backup capacity. Thus, CSP offers firm, flexible electrical production capacity to utilities and grid operators while also enabling effective management of a greater share of variable energy from other renewable sources (e.g. photovoltaic and wind power) (Fig. 3). In this regard, the IEA has proposed certain functions that electric utilities can embark upon to facilitate the growth of CSP (see Table 2). As a consequence, the decision of Iberdrola on being reluctant to adopt CSP can disrupt the growth of CSP and the energy-ecosystem as a whole.

5.1. *Iberdrola S.A: origins and history*

Iberdrola was formed in 1992 (see Fig. 4) through the integration of Hidroelectrica Espanola and Iberduero. In the same year, Iberdrola entered the Latin American market with the acquisition of Litoral Gas and the Guemes Thermal Power Station in Argentina. In 1995, it acquired the electricity distribution companies Electropaz and Elfeo in Bolivia. Iberdrola diversified in 1996 by signing a strategic telecommunications alliance with Telefonica and acquired the Tocopilla and Colbun electric generation utilities in Chile in the same year. In 1997, Iberdrola further expanded its operations in Latin America through the acquisition of Natural ESP in Columbia, and Riogas and CEG in Brazil. In 1999, the company entered the US market by acquiring Energy Works. In 2000, the company entered into a strategic alliance with Eni and Galp for the joint development of gas trading and marketing in the Spanish market.

In 2003, Iberdrola bought eight wind farms from Gamesa to expand its operations in the area of wind power generation. It also established a subsidiary, IOMSA, to undertake the operation and maintenance of all its combined-cycle facilities in Spain. In 2004, Iberdrola entered into an agreement with the Portuguese state government for the reorganization of the Portuguese energy industry, allowing it limited access to industrial customers. In 2005, the company made partial expansions into the UK, France, Qatar, Italy, and Russia, and began the construction of power plants in Brazil and Latin America.

5.2. *Iberdrola S.A: profile*

Iberdrola S.A. generates, distributes, trades, and markets electricity in the United Kingdom, United States, Spain, Portugal, and Latin America. Ibredrola primarily operates in the energy and the electric utilities sector through three main business segments: regulated, liberalized, and renewable energy. The regulated branch consists of energy transmission and distribution services, the liberalized energy division involves the production and sale of electricity and the renewable energy segment focuses on energy production. The total installed capacity of Iberdrola is 46,026 MW (MW), of which 58% is emission free as on FY2011. Iberdrola specializes in clean energy and more specifically wind power (Bloomberg, 2012). Fig. 5 highlights the core capability of Iberdrola in the wind energy accounting for 97% of Iberdrola's renewable energy development.

Table 2
IEA CSP technology roadmap and role of electric utilities.
Source: IEA (2009).

Provide certainty to investors with long-term power purchase agreements or bidding procedures
Reward CSP plants that have firm capacities
Participate actively in project development
Facilitate grid access for CSP developers

6. Concentrated solar power technology: status and future prospects

Utility firms are becoming more and more engaged in the RE development than ever before. This is driven by a mix of regulatory incentives, the need for a hedge against potential carbon regulation and rising fossil fuel prices, and for both base-load and

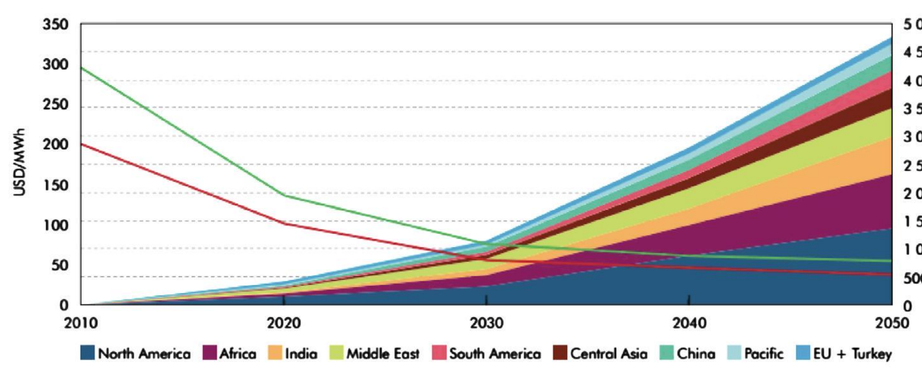

Fig. 3. Technology roadmap for concentrated solar power CSP.
Source: IEA available at www.iea.org.

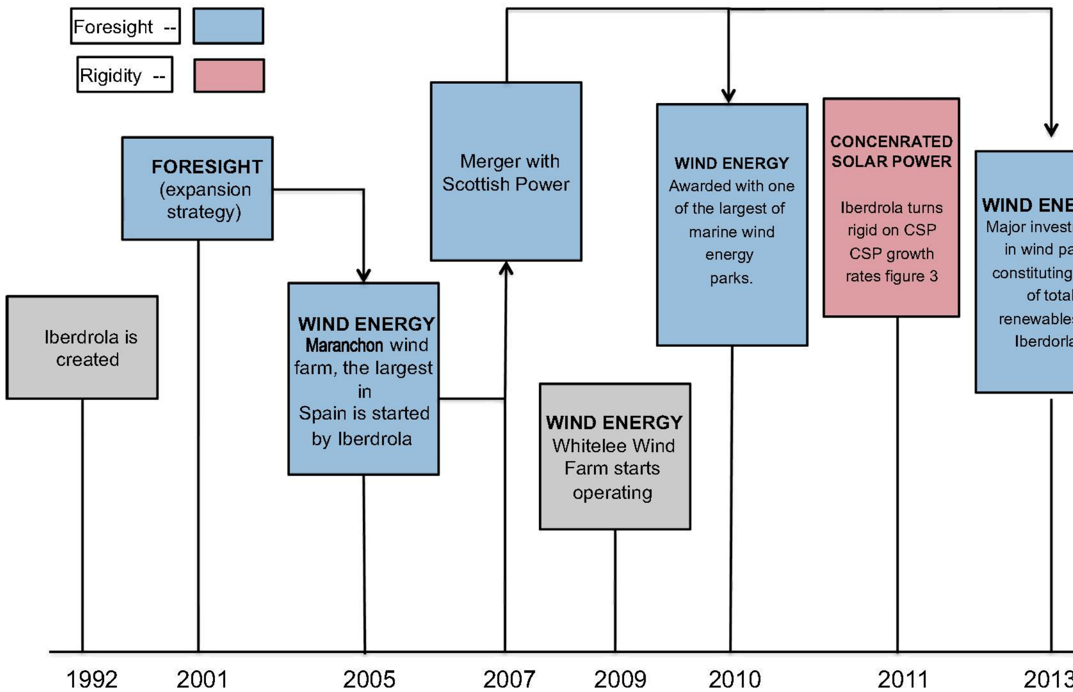

Fig. 4. Timeline for Iberdrola S.A. highlighting strategic foresight and strategic rigidity. These decisions have shaped the technology adoption decisions at Iberdrola S.A.

peaking power capacity with short installation timelines (Renewable Global Status Report, 2010).

This section presents the current status and the future prospects of concentrated solar power technology. Concentrating solar thermal power (CSP) can provide valid solutions to global energy problems and is capable of contributing substantially to CO_2 reduction efforts and make a major contribution to clean energy production because of its ease of scale-up (Cavallaro, 2009). IEA proposes that by 2050, with appropriate support, CSP could provide 11.3% of global electricity, with 9.6% from solar power and 1.7% from backup fuels. Concentrated solar power (CSP) makes use of reflectors to focus sunlight on a small area, in order to power a thermal electric plant. There are several technology variants, including fields of mirrors focusing sunlight on a tower, troughs of mirrors focusing sunlight on pipes, and parabolic dishes focusing sunlight on their apex.

During the 1980s and early 1990s, nine concentrating solar power plants were constructed in California's Mojave Desert for a total of 330 MW. Then, for nearly two decades no new plants were built due to the weakening of the United States federal support for renewables and plummeting energy prices. An 11-MW plant in Spain—the first in Europe—became operational in March 2007. CSP offers a rapidly scalable means of low-carbon electricity generation. Globally, there are more than 45 new CSP projects under development. These are scheduled to generate 5000 MW in North America, 2500 MW in Europe, more than 500 MW in North Africa and 2400 MW elsewhere. Concentrated solar thermal generation is highly predictable, and can be coupled with thermal storage or hybridization, with gas or biomass, enabling stable electricity networks.

Concentrated solar power (CSP) is increasingly valued as a hedge against carbon pricing and as a source of peaking or base-load generating capacity (when paired with thermal storage or natural gas generation). CSP technology promises a competitive value proposition as it is not intermitted and can be delivered to the grid even when there is no solar radiation by making use of thermal storage or hybrid systems. This characteristic makes CSP more flexible than other renewable technologies which are of an intermitted nature, thereby contributing to operator management of the power system according to demand. CSP can be considered as a facilitator for integrating other technologies into the grid, such as photovoltaic or wind, avoiding the need for fossil fuel backup as it can be easily hybridized with other forms of RE, such as biomass, or fossil fuels such as natural gas, thereby increasing the overall efficiency and reliability of power generation (Deloitte and Protermosolar, 2011).

7. Core capabilities, strategic rigidity and competitive advantage

This case illustrates the literature that has been discussed in the paper and emphasizes the possible implications of strategic rigidity in terms of new technology adoption on firm performance. Iberdrola's leadership in RE is mainly based on wind energy with a total installed capacity of 13.45 GW. In FY2011, the company completed La Venta III wind farm in Mexico with a total of 103 MW installed during the year. In Brazil, the consortium formed with Neoenergia, commenced construction which will add up to 288 MW of capacity. In the offshore wind power front Iberdrola has committed the principal investments for the West of Duddon Sands wind farm in Scotland, which is expected to be completed in 2014. In 2009, Iberdrola Renovables opened Europe's largest wind farm in Scotland. The Whitelee wind farm with an installed capacity of 322 MW. Iberdrola Renovables bought the Beii Nee Stipa wind farm in Mexico from Gamesa in January 2011.This facility, which has an installed capacity of 26 MW is the company's second operational wind farm in Mexico, bringing its capacity in the country up to 106 MW. In the same year Iberdrola acquired Brazilian electricity distribution company Elektro for $2.4 billion. Iberdrola Renovables, through group subsidiary Rokas, started up the 38 MW Arachnaio II wind farm in Greece, also in March 2011. These details show that the wind energy can be characterized as Iberdrola's core competence leading to competitive advantage (see Fig. 2). However, in order to further develop its core competencies to adopt to the changes in the industry and sustain its competitive advantage, it is essential for Iberdrola to integrate multiple streams of new technologies with other forms of technologies that are mature. However, Iberdrola has been critical of the potential of CSP technology and thus reluctant to adopt and integrate this technology (CSP-Today, 2012). On the contrary, there is

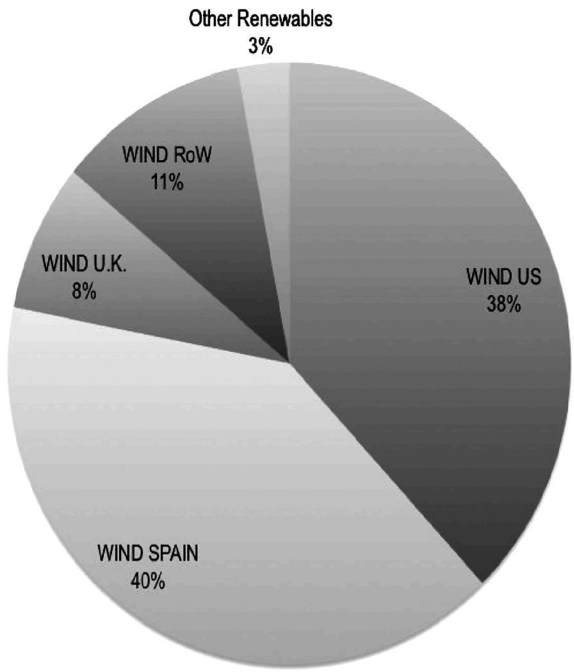

Fig. 5. Iberdrola's renewable energy production by region. Wind energy comprises of almost 97 per cent of the total renewable energy production by Iberdrola. *Source*: Iberdrola S.A. (Iberdrola (2012).

substantial research on the positive implications of CSP and the potential it holds for the clean production of energy (see Table 1). Moreover, the CSP industry is scaling rapidly with 1.2 GW under construction as of 2009 and another 13.9 GW announced globally through 2014 (see figure) (Emerging Energy Research, 2012). This reluctance for the adoption of new technologies can pose a threat for the near future RE deployment in Europe (Renewable Energy Focus, 2009).

8. Discussion and conclusions

Within a firm's context, core capabilities for a firm are evolving and the survival depends on the successful adoption of new technologies and managing that evolution. These decisions can be a source of conflict between the need for new technologies and retention of important capabilities in the mature technologies. In conclusion, a firm's core capabilities are continually evolving and the survival depends upon successfully managing that evolution. Adoption of new technologies and processes are the obvious and visible areas that can give rise to rigidity and leading to conflict between the need for adoption and retention of important capabilities. Strategic foresight activities and peripheral vision, for example with open innovation practices or through corporate venturing activities (including mergers and acquisitions), are becoming more relevant for overcoming these rigidities.

In the case of electric utilities with an intense renewable activity, CSP can be a relevant part of their portfolio and competitive advantage for the future, since there is a significant growth forecasted by the industry. But due to their strategic rigidities the developments are smaller than expected at some firm level.

Moreover, one of the main obstacles to the rapid adoption of CSP technology is lack of awareness by investors, decision makers, politicians and the general public of the technology and it benefits against other alternatives for energy production and storage. One consequence of this lack of awareness is inappropriate decisions being made by policy makers to provide a framework of regulations and incentives that are appropriate for various utility firms to bring things forward.

References

Amabile, T.M., 1988. A model of creativity and innovation in organizations. Research in Organizational Behavior 10, 123–167.

Barney, J.B., 2001. Resource-based theories of competitive advantage: a ten-year retrospective on the resource-based view. Journal of Management 27, 643–650.

Bansal, P., 2005. Responsible strategic decision making. In: Proceedings of the Sixteenth Annual Meeting of the International Association for Business and Society, Sonoma Valley, California, USA.

Bloomberg. ⟨http://www.bloomberg.com/quote/IBE:SM/profile⟩ (accessed 1.6.12).

Bootz, Jean-Philippe, 2010. Strategic foresight and organizational learning: a survey and critical analysis. Technological Forecasting and Social Change 77 (no. 9), 1588–1594.

Cavallaro, F., 2009. Multi-criteria decision aid to assess concentrated solar thermal technologies. Renewable Energy 34, 1678–1685.

Christensen, C., 1997. The innovator's dilemma: when new technologies cause great firms to fail. Harvard Business Press.

Christensen, C.M., Bower, J.L., 1996. Customer power, strategic investment, and the failure of leading firms. Strategic management journal 17 (3), 197–218.

CSPTODAY. Iberdrola: Suddenly Sour on Solar Thermal. Available from: ⟨http://social.csptoday.com/technology/iberdrola-suddenly-sour-solar-thermal⟩ (accessed 1.1.12).

Deloitte and Protermosolar, 2011. VMacroeconomic Impact of the Solar Thermal Electricity Industry in Spain, Madrid, Spain.

Dewar, R.D., Dutton, J.E., 1986. The adoption of radical and incremental innovations: an empirical analysis. Management Science 32 (11), 1422–1433.

Day, G.S., Schoemaker, P.J., 2005. Scanning the periphery. Harvard Business Review 83 (11), 135.

Day, G.S., 1994. The capabilities of market-driven organizations. Journal of Marketing 58, 37–52.

Eisenhardt, K.M., Zbaracki, M.J., 1992. Strategic decision-making. Strategic Management Journal, 17–37.

Emerging Energy Research. ⟨http://www.renewableenergyworld.com/rea/news/article/2009/05/global-concentrated-solar-power-industry-to-reach-25-gw-by-2020⟩ (accessed on 1.6.12).

Ettlie, J.E., Bridges, W.P., O'keefe, R.D., 1984. Organization strategy and structural differences for radical versus incremental innovation. Management science 30 (6), 682–695.

Ferrier, W., Smith, K.G., Grimm, C.M., 1999. The role of competitive action in market share erosion and industry dethronement: a study of industry leaders and challengers. Academy of Management Journal 42 (4), 372–388.

Fleming, F., 2001. Recombinant uncertainty in technological search. Management Science 47, 117–132.

Fleming, L., Sorenson, O., 2004. Science as a map in technological search. Strategic Management Journal 25, 909–928.

George, G., Kotha, R., Zheng, Y., 2008. The puzzle of insular domains: a longitudinal study of knowledge structuration and innovation in biotechnology firms. Journal of Management Studies 45, 1448–1474.

Hayes, R.H., 1985. Strategic planning-forward in reverse? Harvard Business Review, 111–119.

Iberdrola S.A. ⟨http://www.iberdrola.es/webibd/corporativa/iberdrola?cambioIdioma=ESWEBCONLINRENOVABLES⟩ (accessed 1.6.12).

IEA, 2009. ⟨http://www.iea.org/publications/freepublications/publication/csp_roadmap.pdf⟩.

Karshenas, M., Stoneman, P.L., 1993. Rank, stock, order, and epidemic effects in the diffusion of new process technologies: An empirical model. The RAND Journal of Economics, 503–528.

Kimberly, J.R., Evanisko, M.J., 1981. Organizational innovation: The influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. Academy of management journal 24 (4), 689–713.

Leonard-Barton, D., 1992. Core capabilities and core rigidness: a paradox in managing new product development. Strategic Management Journal 13, 111–125.

Lieberman, M., Montgomery, D.B., 1988. First-mover advantages. Strategic Management Journal 9, 41–58.

Mitchell, W., 1989. Whether and when? Probability and timing of incumbents' entry into emerging industrial subfields. Administrative Science Quarterly 34, 208–230.

March, J.G., 1991. Exploration and exploitation in organizational learning. Organization Science 2, 71–87.

Nisar, Arsalan, Ruiz, Felipe, Palacios, Miguel, 2013. Organisational learning, strategic rigidity and technology adoption: implications for electric utilities and renewable energy firms. Renewable and Sustainable Energy Reviews 22, 438–445.

Penrose, E., 1959. The Theory of the Growth of the Firm. Oxford University Press, New York, USA.

Quinn, J.B., 1980. In: Irwin, Richard D., Strategies for Change: Logical Incrementalism. Homewood, IL, USA.

REN21, 2010. Renewables 2010 Global Status Report. REN21 Secretariat, Paris, France.

Renewable Energy Focus, 2009. Concentrated Solar Thermal Power (CSP) Market Could Reach 24 GW by 2020.
RechargeNews. ⟨http://www.rechargenews.com/business_area/finance/article303237.ece⟩ (accessed 28.5.12).
Rumelt, R.P., 1974. Strategy, Structure and Economic Performance. Harvard Business School Classics. Harvard Business School Press, Boston, MA, USA.
Richard, D., Weick, K.E., 1984. Toward a model of organizations as interpretation systems. Academy of Management Review 9, 284–295.
Miles, R.E., Snow, C.C., 1978. Organizational Strategy, Structure and Process. McGraw-Hill, New York.
Selznick, P., 1957. Leadership in Administration: A Sociological Interpretation. Row, Peterson and Co, Evanston, IL.
Sirmon, D.G., Hitt, M., Jean-Luc Arregle, A., Campbell, J.T., 2010. The dynamic interplay of capability strengths and weaknesses: investigating the bases of temporary competitive advantage. Strategic Management Journal 31, 1386–1409.
Srinivasan, R., Lilien, L., Rangaswamy, A., 2002. Technological opportunism and radical technology adoption: an application to e-business. Journal of Marketing 66, 47–60.
Tushman, M.L., Anderson, P., 1986. Technological discontinuities and organizational environments. Administrative Science Quarterly 31, 439–465.
Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strategic Management Journal. 18, 509–533.
Woiceshyn, J., Daellenbach, U., 2005. Integrative capability and technology adoption: evidence from oil firms. Industrial and Corporate Change 14, 307–342.
Wernefelt, B., 1984. A resource-based view of the firm. Strategic Management Journal 5, 171–180.
Wiggins, R.R., Ruefli, T.W., 2005. Schumpeter's ghost: is hyper competition making the best of times shorter? Strategic Management Journal 26 (10), 887–911.
Wustenhagen, R., Menichetti, E., 2012. Strategic choices for renewable energy investment: conceptual framework and opportunities for further research. Energy Policy 40, 1–10.
Zmud, R.W., Apple, L.E., 1992. Measuring technology incorporation/infusion. Journal of Product Innovation Management 9 (2), 148–155.